

# New Approaches in Cartographic Relief Representation with Morphometric Variables

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**Abstract.** This paper discusses new approaches to mapping terrain with morphometric variables.

**Keywords:** DEM, Relief, Hillshading, Morphometry

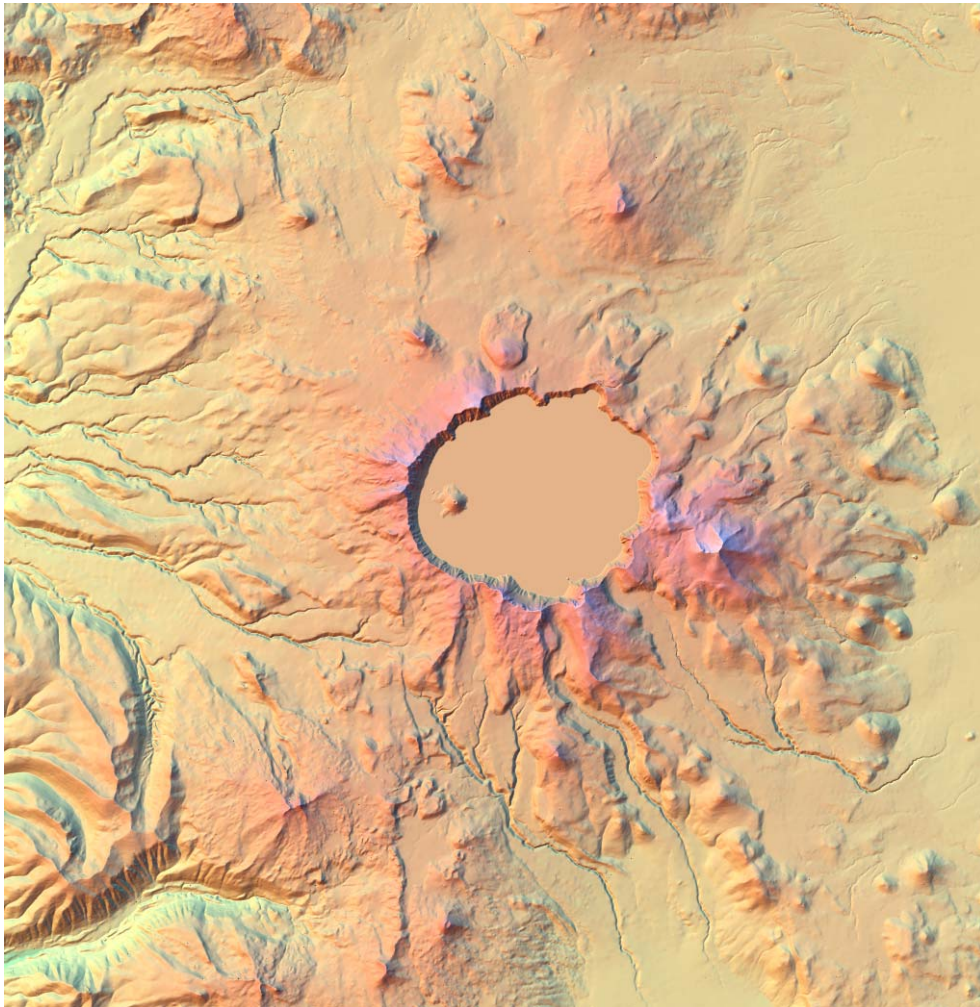
## 1. Introduction

Currently analytical hillshading is intensively used in relief representation. Light reflection intensity is used to imitate shadows on the surface with different reflection models (Horn 1981). Typically, Lambert reflection model is applied with one or more point sources of light with the addition of a constant diffuse light (Kennelly & Stewart 2006). Many methods to improve analytical hillshading are proposed (Lukas & Weibel 1995), but these improvements relate primarily transmitted to emphasize surface shape and, more rarely, structural lines. Various relief form types are represented in the images to a lesser extent.

## 2. New Approaches and Software Development

In the last 10-15 years experiments emerged that try to emphasize relief forms and structure by using of different morphometric variables, such as slope, aspect, various types of curvatures (Kennelly 2008), positive, negative and average openness (Yokoyama et al 2002), sky view factor (Zakšek et al, 2011) and so on. A typical example of this is the method called by the authors Red Relief Image Map (Chiba et al 2008).

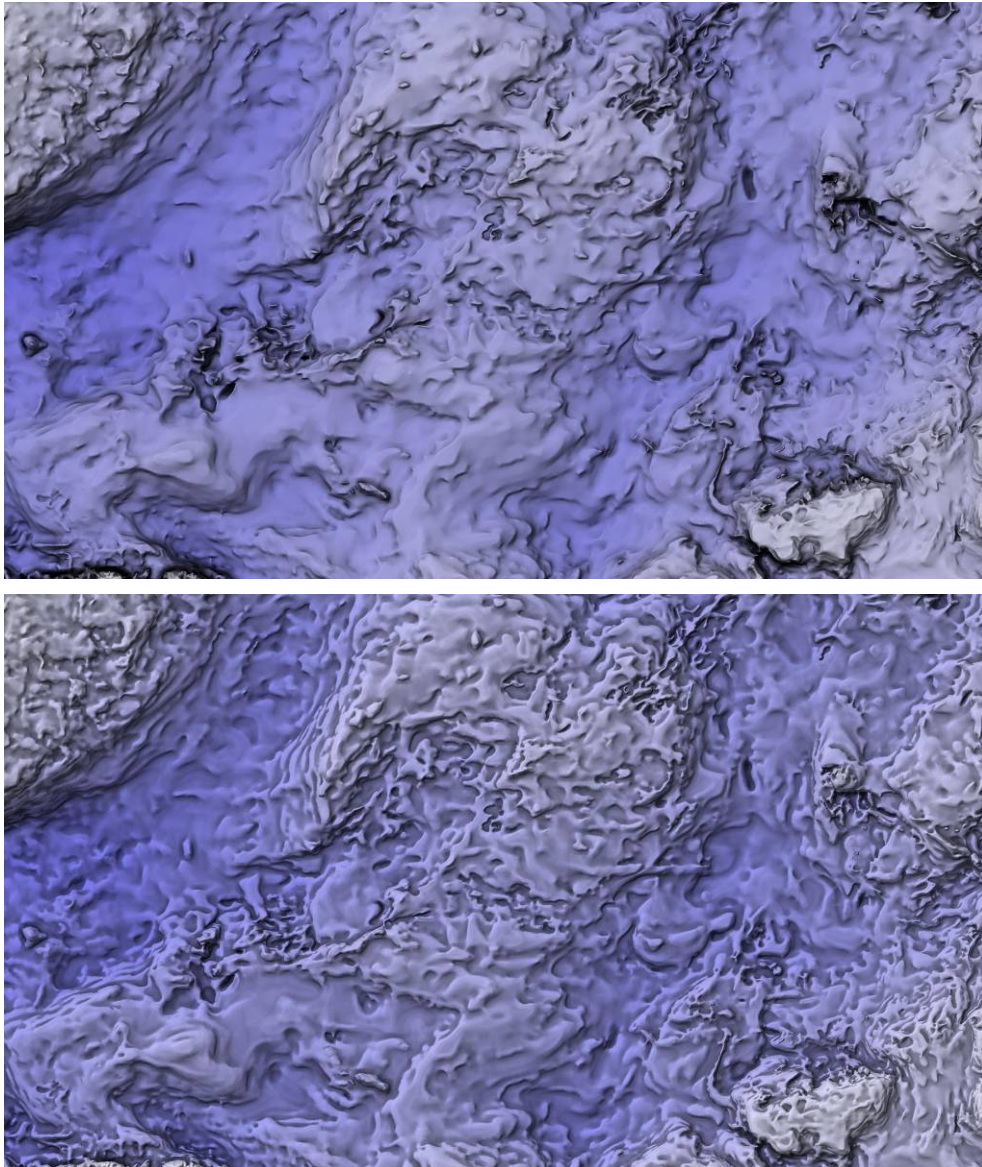
Since most of the proposed traditional hillshading algorithms and new relief representation methods with the use of morphometric variables is not implemented in popular GIS packages, it was decided to develop its own software, which can be used both for practical reasons and for the training of students to new methods in the course of digital cartography.



**Figure 1.** Crater Lake (USA): combination of colored elevation and colored hillshading (three color – Red, Green, Blue – light sources with different azimuths are used)

Developed software was tested on different types of terrain, making it possible to explore the advantages and disadvantages of different methods of displaying some type of relief and develop some guidelines. We also experimented with combination of gray-scale hillshading or morphometric varia-

ble image with color thematic content (for example, colored elevation or geological regions). For this purpose we use traditional methods of combination (multiply, overlay with transparency etc.) and specially developed methods (Koshel et al. 2012) combining gray and color images that preserve color perception on synthesized image as in legend.



**Figure 2.** Barents Sea bottom relief: combination of colored elevation, analytical hillshading and sky view factor (above) or average openness (below).

### 3. Conclusion

A result of researches developed software that allows you to create a relief image using classical analytical hillshading with many improvements, and a number of morphometric parameters. In one image can be combined in different ways multiple images, which gives a wide choice of ways for create a picture, most impressively represented its data for a particular purpose.

*Figure 1* and *Figure 2* Figures illustrate some possibilities of the developed software.

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